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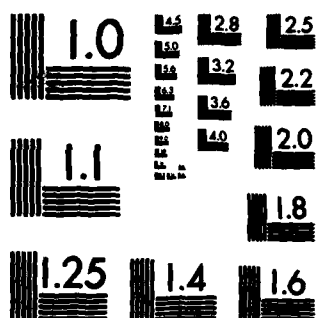
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STUDY IN
SPURIOUS SENSITIVITY
OF
ELECTRONICS

SECOND QUARTERLY REPORT

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19. ABSTRACT (Continue on reverse if necessary and identify by block number) <p>A measurement program in which a proton beam irradiates sensitive electro-optical sensors used in spacecraft systems has been prepared. The progress reported during this period includes device procurement and testing of photomultiplier tubes at the Los Alamos Meson Physics Facility. The micropulse structure of the LAMPF beam is ideal for measuring transient response of the photomultiplier tubes. Each tube was placed in the beam head on so that all parts were exposed and side on so that only the electron multiplier was irradiated.</p>												
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Program Objectives

A measurement program in which a proton beam irradiates sensitive electro-optical sensors used in spacecraft systems is being prepared. This testing is to be in two segments using beam time at the Indiana University Cyclotron Facility, Harvard Cyclotron or Los Alamos Meson Physics Facility.

The initial testing will investigate sensors with high gain but which do not require cooling. Photomultiplier tubes and avalanche photodiodes meet these requirements and are frequently used in star trackers, imaging systems, surveillance systems, warning systems and other scientific instrumentation. Later testing will be performed on other types of photodiodes and infrared sensors.

Procurement

ITT-A/OD has received three photomultiplier tube types manufactured by A/ODs sister division the Electro-Optical Products Division. These include an FW-130 with a small cathode, 16 stages and a gain of 10^6 ; an F-4085 with the same characteristics but a larger cathode; and an F4012 with 11 stages and a gain of 10^5 . The FW-130 and F-4085 are intended for photon counting. The F4012 can be used in either an analog or digital mode. In addition, three RCA avalanche photodiode types have been ordered -- 30902E, 30817, and 30916E. The 30902E and the 30817 have been received. Three PIN-10 Shottky Barrier detectors have been ordered and received from United Detector Technology. Five photoconductive (SD-100-12-12-021) and five photovoltaic (SD-100-12-22-021) photodiodes have been ordered and received from Silicon Detector Corporation.

LAMPF Testing

ITT-A/OD accepted the offer of free beam time from Captain Richard Joseph of DNA at the Los Alamos Meson Physics Facility during the first week in February. A summary of the data taken at LAMPF from two photomultipliers and an image dissector tube are attached. Because of the randomness of run times and the usual problems with initial testing at large facilities, ITT-A/OD was invited back for more free beam time in a few months. This will provide a chance to refine measurements and test photodiodes and/or I R detectors.

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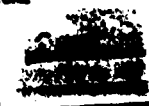
The pulse structure of the LAMPF accelerator normally consists of macropulses 720 μ s long repeating at either 80 Hz or 120 Hz shown in the attached figure. Each macropulse is made up of micropulses each approximately 200 ps long containing 10^7 - 10^8 protons separated by 4.97 ns. The proton energy is normally 800 MeV. For this test the proton energy was 318 MeV; the time between micropulses was increased to 4.5 μ s and the repetition rate was variable from 1 - 8 Hz. The beam is ideal for measuring transient response allowing the photomultiplier tube to recover partially between micropulses and completely every 720 μ s.

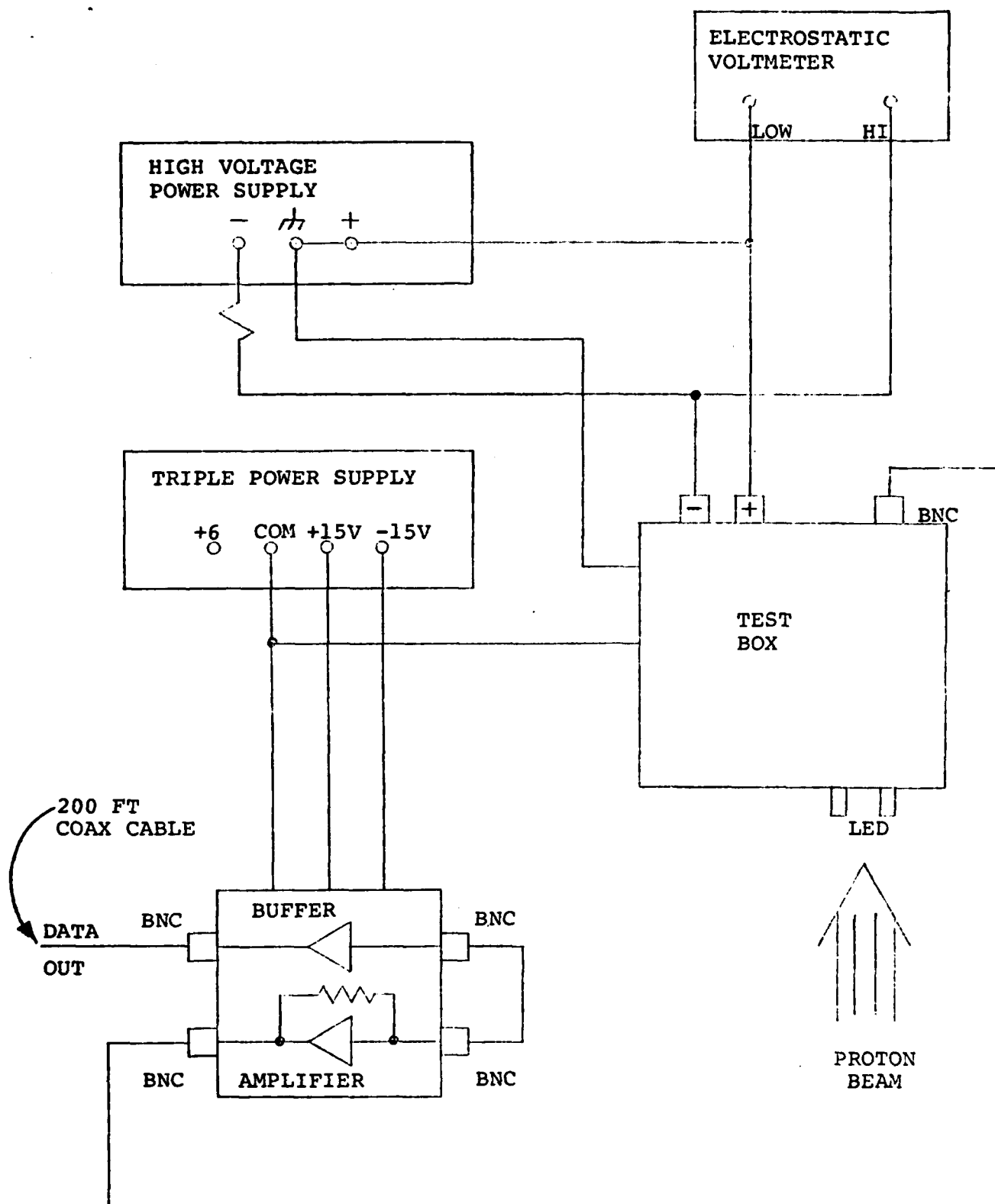
The test equipment consisted of high voltage power supply for the photomultiplier tube, and amplifier, line driver, and associated power supply to accommodate the approximately 200 ft. of BNC cable and oscilloscope to monitor the anode output. The connections are shown in the attached test configuration drawing. Measurements were made using an oscilloscope display from two different beam orientations to the tube: head on passing completely through the tube and side on hitting the electron multiplier. The three tubes tested an FW129, FW130, and F 4012.

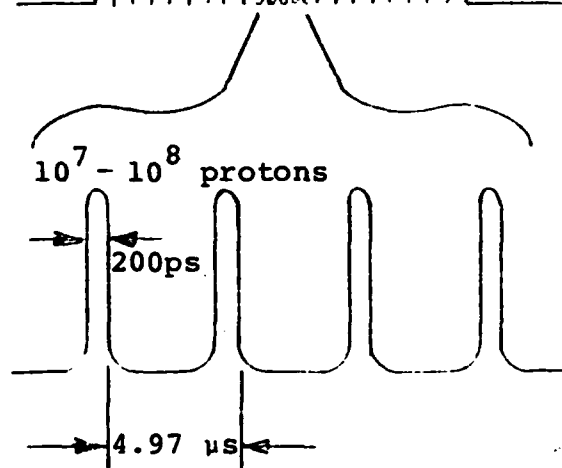
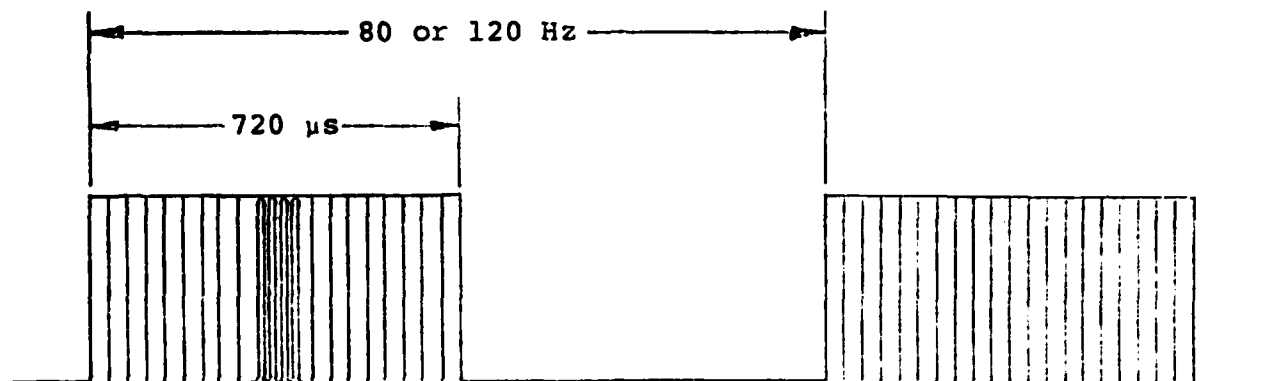
The first data picture shows the photomultiplier tube output during one "macropulse" and the subsequent recovery during the time between pulses. The structure during the "macropulse" is due to micropulses. Details are shown in the second picture. The smaller pulses after the main pulse are thought to be afterpulsing in the tube rather than beam structure. The third picture shows details of the recovery. The final two pictures are with the beam hitting the electron multiplier. The response of the tube is less than with the beam head on.

Future Plans

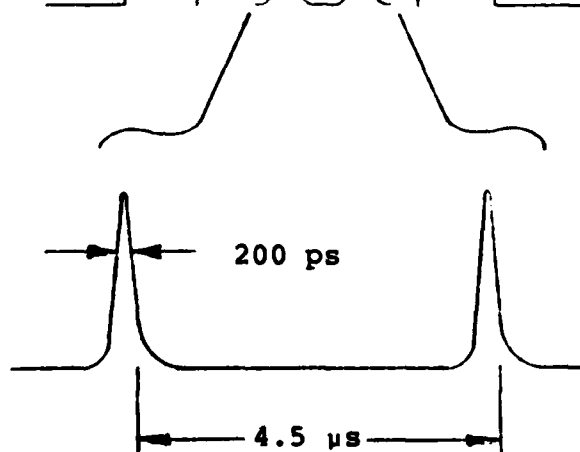
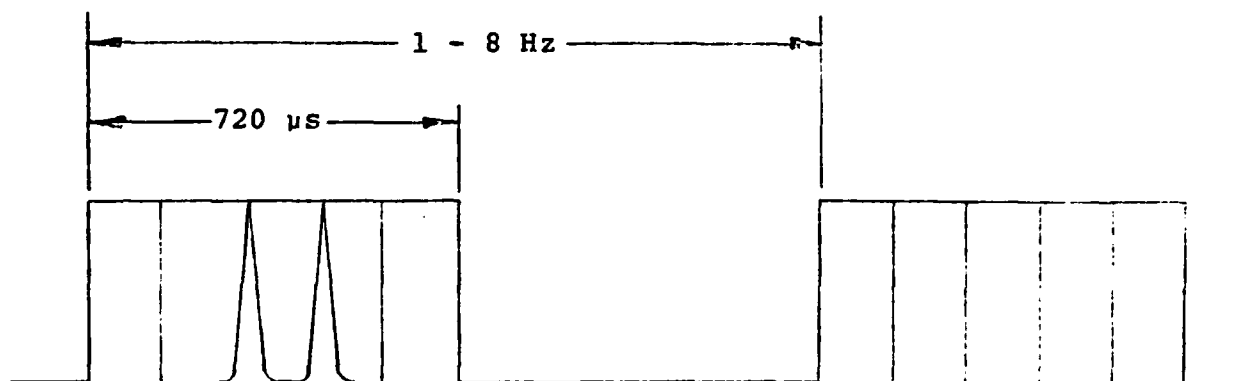
Additional testing will be performed at either LAMPF or the Harvard Cyclotron Facility or possibly both in June or July. The Harvard Cyclotron has been chosen because of its low cost, availability, and ability to measure beam current over a wide range.

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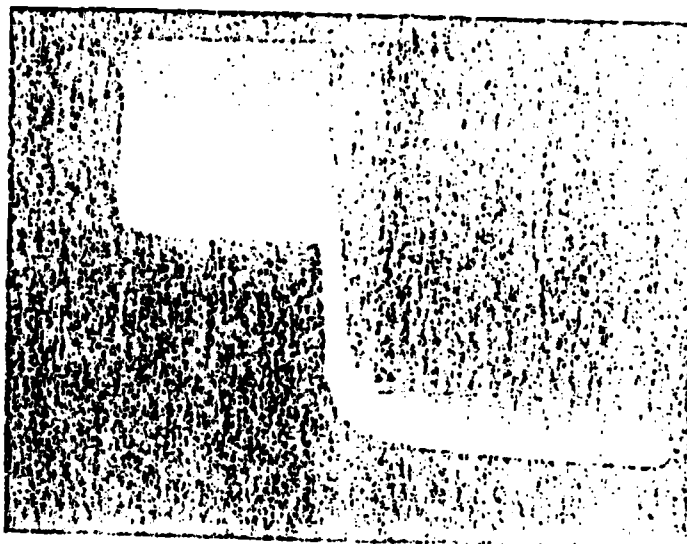
MACRO PULSE MODE



MICROPULSE MODE

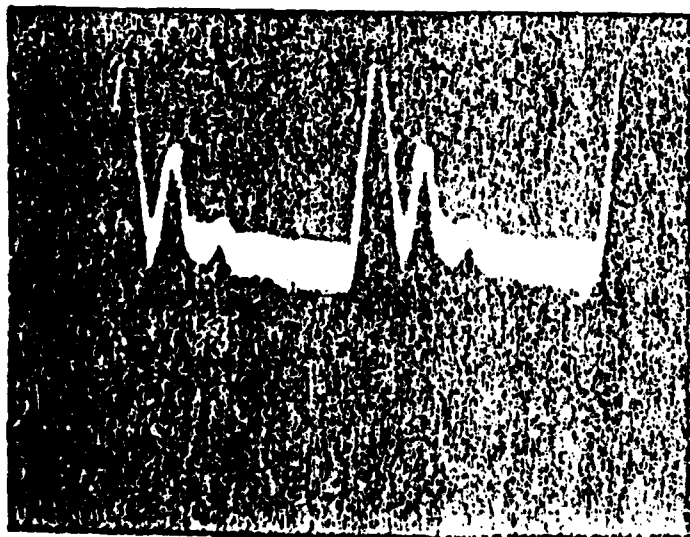
FW 129

FACEPLATE INCIDENT



1V/div 0.2 μ sec/div

MACROPULSE STRUCTURE



1V/div 1 μ sec/div

MICROPULSE STRUCTURE

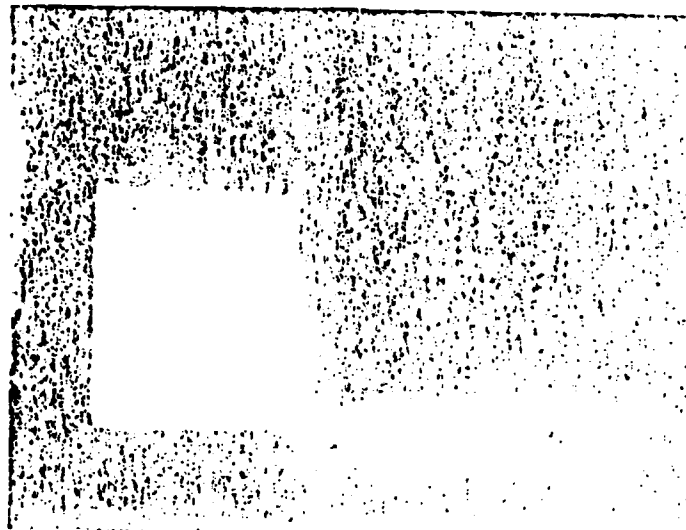


0.5V/div 20 μ sec/div

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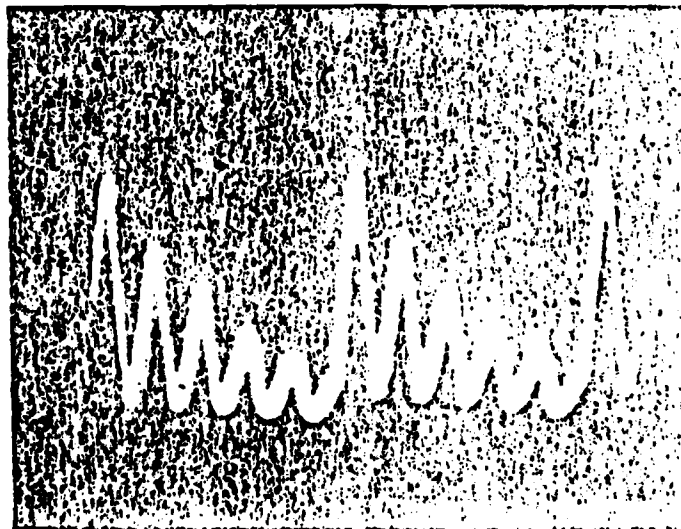
FW 129

ELECTRON MULTIPLIER INCIDENCE



1V/div 0.2 μ sec/div

MACROPULSE STRUCTURE



1V/div 1 μ sec/div

MICROPULSE STRUCTURE

ILME